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Periorbital Skin Resurfacing Using High Energy Erbium:YAG Laser: Results in 50 Patients

Robert A. Weiss, MD,[1]* Allan C. Harrington, MD,[2] Richard C. Pfau, MD,[3] Margaret A. Weiss, MD,[1] and Sangeeta Marwaha, MD[4]

[1]Department of Dermatology, Johns Hopkins University School of Medicine, Baltimore, Maryland
[2]Dermatologic Surgery, Maryland Skin and Laser Institute, Baltimore, Maryland
[3]Department of Dermatology and Dermatopathology, University of Maryland, Baltimore, Maryland
[4]Private practice, Stockton, California

Objective: **To evaluate Erbium:YAG regional periorbital laser resurfacing clinically and histologically.**
Study Design/Materials and Methods: **Photographic evaluation before and after Erbium:YAG resurfacing with histologic evaluation of depth of injury. Setting: Group private single specialty practice. Patients: Fifty patients in the age range of 35–62 years, Fitzpatrick skin types I–III were treated using Erbium:YAG for regional resurfacing of periorbital rhytides. Outcome Measures: Patients were seen at days 1, 2, 3, 7, 14, 28, and at six months and one year. Photographs were obtained prior to application of topical anesthesia and were utilized to judge improvement of rhytides at all time intervals. Additional photographs were taken at each follow-up visit and the results judged by an independent investigator. Results were graded into five categories at all treatment intervals: no improvement, mild (grade 1: up to 25%), moderate (grade 2: 25–50%), good (grade 3: 50–75%, or excellent (grade 4: 75–100%). For histologic evaluation of depth of ablation and thermal injury one, two, and three passes at 21.2 J/cm^2 were performed on four patients.**
Results: **Re-epithelization in the periorbital region was rapid with a mean duration of 2.65 days. Erythema ranged from a longest of six weeks to the shortest of seven days with a mean duration of 15.4 days. Evaluation of clinical results revealed that at two weeks mean improvement was 2.15 (between moderate and good). At four weeks further improvement was noted with a mean of 2.62. By six months, mean improvement score increased to 2.94. Minimal further improvement was noted between six months and one year with a mean improvement score of 3.02 (good to excellent). Histology revealed complete removal of the epidermis with one to three passes. Dermal ablation of**

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*Correspondence to: Robert A. Weiss, MD, 54 Scott Adam Road, Hunt Valley, MD 21030. E-mail: rwderm@home.com

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5–10 microns accompanied by small increases (5–10 μ) in dermal thermal injury occurred with each subsequent pass.
Conclusions: **We conclude that high energy Erbium:YAG periorbital resurfacing is a safe and effective modality which achieves substantial therapeutic effect. Most patients achieve approximately 75% improvement. Erythema fades quickly, re-epithelization is rapid and side effects are minimal. Lasers Surg. Med. 24:81–86, 1999.** © 1999 Wiley-Liss, Inc.

Key words: Er:YAG laser; skin; Erbium; collagen; methods; laser surgery

INTRODUCTION

The demand for repair of sun-damaged skin continues to rise. The ideal procedure would be a method that yields highly effective results with very short healing time and minimal need for anesthesia, as well as minimal intra and postoperative discomfort. Since the original publication of the use of pulsed CO_2 for laser resurfacing, dermatologic surgeons agree that it is necessary to remove the epidermis and portions of the dermis with creation of a zone of contractile thermal injury in order for collagen shrinkage and collagen production to occur [1].

Although the CO_2 laser is efficient at removing the epidermis, the depth of thermal injury can result in unintended effects such as scarring, pigmentation changes, and prolonged wound healing [2]. Patients may be at risk for these unpredictable complications even with the most experienced of operators. At a CO_2 wavelength of 10,600 nm thermal conduction is increased with ablated debris in the path of the beam. By contrast the erbium (Er):YAG laser, with a wavelength of 2,940 nm, emits at the peak absorption of water and resides in close proximity to a 3,030 nm absorption peak of collagen. As a result of the affinity for water, almost all of the energy is converted to the energy of water vaporization minimizing thermal buildup within the tissue. Tissue is disrupted and removed by direct ablation and the acousto-mechanical sequelae of explosive vaporization of the tissue water [3].

In a recent study when 20 patients were treated with the Er:YAG laser for perioral, periorbital, and forehead rhytides, improvement was seen in all 20 patients followed to eight weeks. Treatment parameters utilized were 400–800 mJ delivered in spot sizes between 2.5 and 5 mm (fluences of 5–10 J/cm^2). Re-epithelization occurred rapidly between 4 and 10 days. Postoperative erythema resolved in less than two weeks [4]. When computerized scanning is added to the Er:YAG laser, ablation is precise and homogenous. In a study of 141 patients with scanned Er:YAG, erythema was much less marked than with CO_2 laser and the erythema usually disappeared within 3–4 weeks. It was noted that fluences of at least 20 J/cm^2 were necessary to produce new collagen formation [5]. A recent study of 100 patients comparing several passes of Er:YAG with several passes of a 950 μsec pulse CO_2 laser demonstrated markedly reduced erythema, complication rate, and rapid re-epithelization for Er:YAG [6].

The purpose of our study was to examine the effects of relatively high fluence Er:YAG in the periorbital region. Patients were followed for one year to evaluate improvement and side effects. In addition, histologic confirmation of depth of ablation with our parameters were performed.

MATERIALS AND METHODS

Fifty patients in the age range of 35–62 years, Fitzpatrick skin types I–III were treated using Er:YAG for regional resurfacing of periorbital rhytides. All treatments were performed using only topical anesthesia, which consisted of EMLA cream (Astra Pharmaceuticals LP, Wayne, PA) applied under occlusion for 1 hour. Some patients (< 10%) required oral Valium and/or Demerol 50 mg IM to continue the procedure after the first pass. Oral prophylaxis consisted of Valtrex 500mg BID for three days and Duricef 500 BID for three days starting the day of the procedure. To decrease immediate (5–10 minutes) urticarial edema, all patients received loratadine, 10mg at 30 minutes prior to the procedure. This urticarial edema typically lasts for 2–3 hours before spontaneously resolving.

Patients were seen at days 1, 2, 3, 7, 14, 28, and at six months and one year. Photographs were obtained prior to application of topical anesthesia (Canfield double flash system on Nikon N90, Ektachrome 100 film, Canfield Clinical Systems, Cedar Grove, NJ) and were utilized to judge improvement of rhytides at all time intervals. Ad-

ditional photographs were taken at each follow-up visit and the results were judged by an independent investigator and the treating physician. Averaged results were graded into five categories at all treatment intervals: no improvement, mild (grade 1: up to 25%), moderate (grade 2: 25–50%), good (grade 3: 50–75%), or excellent (grade 4: 75–100%). All side effects were noted. Treatment parameters utilized were two passes at a setting of 1.5 joules using a 3 mm collimated handpiece for a fluence of 21.2 J/cm^2 (Derma 20 and Derma K, ESC/Sharplan Medical Systems Inc, Needham, MA). A third pass with a 3mm spot size at a fluence of 15 J/cm^2 directly over the depth of the wrinkle line was also performed in all cases. Side effects of erythema, pigmentation, and others were recorded.

For histologic evaluation of depth of ablation and thermal injury with these parameters, one, two, and three passes at 21.2 J/cm^2 were performed on skin of four patients undergoing reconstruction following skin cancer removal with Mohs micrographic surgery. The tissue utilized in the evaluation was from Burrow's triangles from the upper check and post-auricular regions, which ordinarily would have been discarded.

RESULTS

Re-epithelization, as defined by no areas of weeping, was very rapid with a mean duration of 2.65 days. Erythema ranged from a longest of 6 weeks to the shortest of seven days with a mean duration of 15.4 days. At least slight erythema was noted in 80% at week 2 but diminished to 5% at week 4 (Fig. 1). Evaluation of clinical improvement was based on photographic assessment, which revealed that at two weeks mean improvement was 2.15 (between moderate and good). At four weeks further improvement was noted with a mean of 2.76 (Fig. 2). By six months, mean improvement score had increased to 2.94. Very minimal further improvement was noted between six months and one year with a mean improvement score of 3.02 (good to excellent) (Fig. 3).

Side effects included two cases of mild acneiform dermatitis/folliculitis thought to be due to continuation of occlusive topicals beyond four days. Occlusive, petrolatum based topicals are now discontinued at 2–3 days with water based moisturizers used following day 3 for pure Er:YAG treatments. The acneiform eruptions were treated with two weeks of oral antibiotics. Immediate (within 15 minutes) periorbital edema which appeared urticarial in nature was seen in 90% of patients with resolution of this ballooning type of swelling within two hours by patient history. A milder more typical postoperative edema was seen in 41 out of 50 patients at 24 hours, clearing by day 3. No pigmentation changes be-

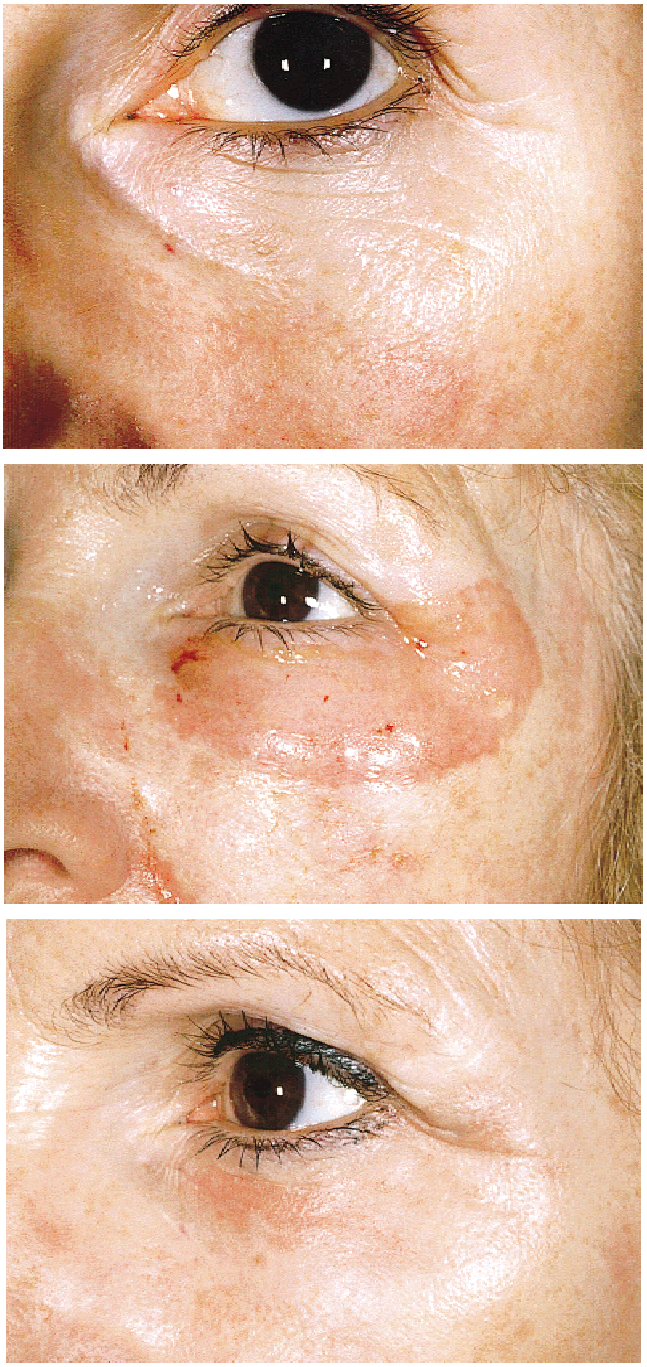

Fig. 1. **A**: Before treatment. **B**: Day 1 postoperative. Salmon pink erythema is typical with small amounts of clear exudate. **C**: Typical streaky erythema at week 2. No pigmentation changes are noted.

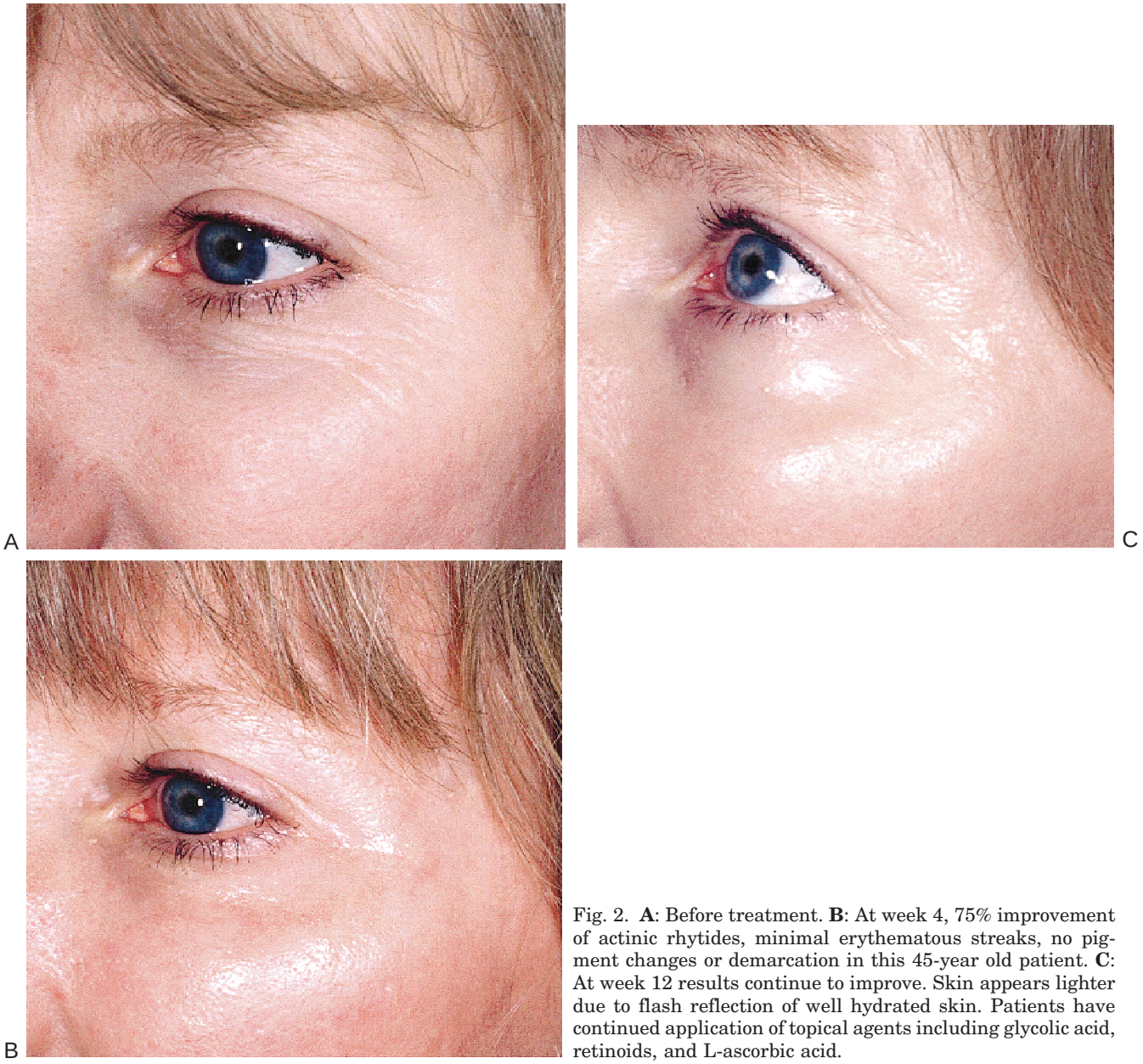

Fig. 2. **A**: Before treatment. **B**: At week 4, 75% improvement of actinic rhytides, minimal erythematous streaks, no pigment changes or demarcation in this 45-year old patient. **C**: At week 12 results continue to improve. Skin appears lighter due to flash reflection of well hydrated skin. Patients have continued application of topical agents including glycolic acid, retinoids, and L-ascorbic acid.

yond two months were noted. Five patients experienced hyperpigmentation lasting approximately four weeks, these were all skin type III. No color demarcation was observed at the borders between Er:YAG ablated and non-Er:YAG ablated skin beyond four weeks. Subjects did not have significant actinic related pigmentation changes on the adjacent cheeks prior to the procedure.

Histology

The skin removed immediately following high energy Er:YAG laser ablation showed complete removal of the epidermis with one to three passes. (Fig. 4) Beneath the areas of epidermal loss, there was a very small zone of papillary dermal thermal injury that was represented by a somewhat hyalinized eosinophilic staining measuring approximately 10 μ. We observed that with additional passes there was a trend toward small increases in dermal ablation of 10 μ accompanied by small increases (10 μ) in dermal thermal injury.

DISCUSSION

Substantial benefit may be obtained by relatively high power Er:YAG ablation of the perior-

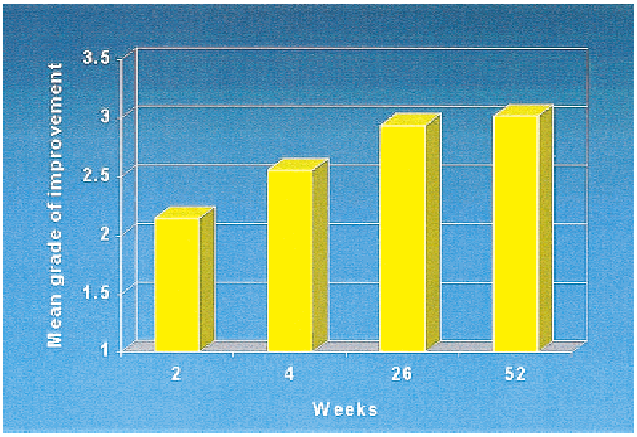

Fig. 3. Grades of improvement vs. time. Results are graded into five categories at all treatment intervals: no improvement, mild (grade 1: up to 25%), moderate (grade 2: 25–50%), good (grade 3: 50–75%), or excellent (grade 4: 75–100%). Final results at one year demonstrate approximately 75% improvement.

bital region. Some investigators have reported minimal improvement in actinic rhytides and have achieved only partial epidermal ablation with low fluences even with several non-collimated beam passes of between 5–10 J/cm^2 [7]. Our study demonstrates that with a fluence over 20 J/cm^2, using a colimated beam, it is possible to ablate most of the epidermis on the first pass, and achieve some dermal ablation with minimal thermal injury with additional passes.

Rapid re-epithelization is due to the very narrow zone of thermal destruction as compared to CO_2 resurfacing. From the clinical photographs, it appears that some collagen or elastic fiber synthesis continues for a duration of six months to a year. This is similar to the results observed by the authors following mechanical dermabrasion of the epidermis and was unexpected for Er:YAG. Histologic findings show that the epidermis is removed in most locations after one pass, subsequent passes cause less injury probably due to the higher water content of the target with tissue fluid exudate.

While some patients showed no further improvement after six months, a small percentage showed continued improvement. Some of this may be due to the fact that all postoperative care includes the application of retinoids, L-ascorbic acid, and alpha-hydroxy acids beginning 4 weeks after the procedure.

Erythema disappears quickly, with only small isolated streaks of erythema continuing to 4–6 weeks. Although some temporary hyperpigmentation was occasionally observed, resolution

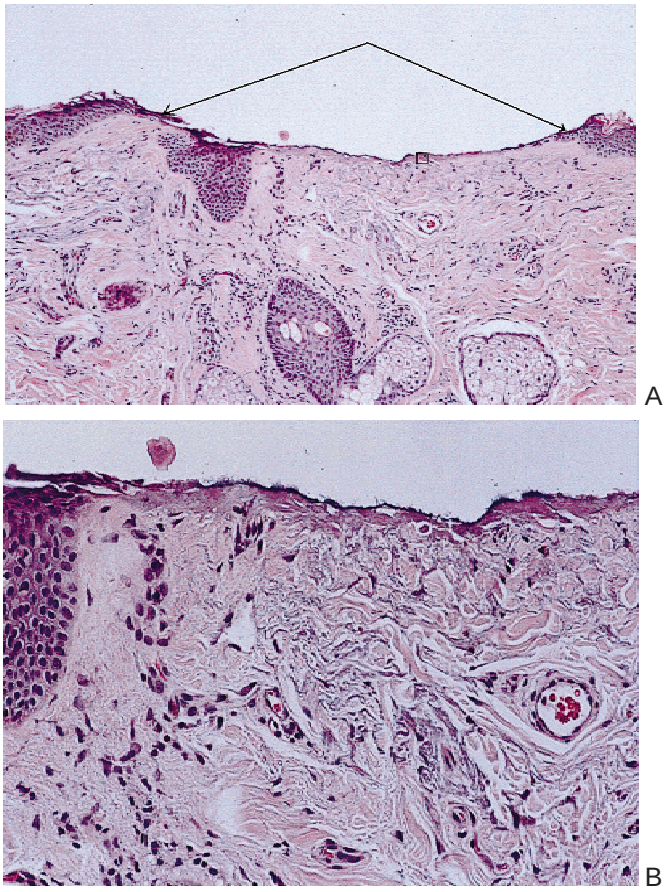

Fig. 4. **A**: H & E (200×). Arrows show crater of impact of 3 mm collimated beam held 1 cm above the skin surface with complete ablation of epidermis seen after three passes repeated over the identical spot. Thermal injury beyond the zone of impact is 10 μ (box). **B**: H & E (400×). Close-up of crater showing narrow zone of residual thermal damage in dermis.

was rapid. No patient developed a demarcation line in the zone where Er:YAG treated skin apposed untreated skin. In most patients a feathering of Er:YAG at the treatment borders was performed at half the treating fluence for a final pass. No scarring was observed except for one patient developed a 2 mm small pitted scar from one impact site which was visible for six months before resolution. No skin infections were recorded.

We conclude that high energy Er:YAG resurfacing is a safe and effective modality which achieves substantial therapeutic effect in the periorbital region. Erythema fades quickly, re-epithelization is rapid, and results rival CO_2 resurfacing with most patients achieving approximately 75% improvement. Morbidity is less than reported with other CO_2 methods and resurfacing in the periorbital region can be performed with lessened concern for cosmetic demarcation lines.

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